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A study was undertaken to test the assumption that students will interact with illustrations in textbooks, workbooks, and programed units; and that this interaction will facilitate learning. Eight test groups were compared with a group that had only verbal symbols to learn from. These groups had, in addition to the verbal descriptions, the black and white of color versions of abstract line representations, drawings (detailed and shaded), heart model photographs, and realistic photographs. Five criterion measures were used to test the relative learning under the different conditions. The visually-aided programed material was not found to be significantly superior to the control group material consisting solely of verbal symbols. It was concluded that students do not know how to learn from drawings and photographs, that a continuum of visual illustrations extending from line drawing to the object itself is not an effective predictor of learning, that color can aid some student achievement, and that, in general, students given the abstract line illustrations took longer to complete their instructional units. (RP)

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The Effect of Varying the Amount of Realistic Detail in Visual Illustrations Designed to Complement Programed Instruction *

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Introduction

At the present time many textbooks, workbooks, programed units, etc., contain a proliferation of various types of visual illustrations. In the production of these educational materials it has been assumed that the student while working on his assignments will interact with these illustrations, and that they will in some way assist him in learning the content material.

At the present time there is very little experimental evidence available as to how learners react to the various types of visual illustrations and to the variations in the amount and kind of realistic detail which they contain. In some cases it may be that the types of illustrations that are being used to facilitate the learning process may actually be hindering it. Consequently, it seems necessary that guidelines be developed which will enable educators to include in instructional texts those types of visual illustrations which will be most economical and effective in promoting student achievement of desired learning objectives. Allen (1), Hoban (8), Schramm (10) and Dwyer (4) (5) have stated that extensive research needs to be conducted on the physical characteristics inherent within visual illustrations which lead to increased learning and to the achievement of specific educational objectives.

While the literature on the instructional effectiveness of the various types of visual illustrations is sparse, several theoretical orientations (Finn (6), Dale (3), Morris (9), Carpenter (2), Gibson (7)) have been developed which contend that learning will be more complete as the number of cues in the learning situation increases (See Figure 1). They also suggest that an increase in the realistic detail of the existing cues in the learning situation increases the probability that learning will be facilitated.

Figure 1. Realism Continuum for Still Visuals

Verbal Symbols

Abstract Line Representations (B & W)

Abstract Line Representations (Color)

Drawings (detailed and shaded--B & W)

Drawings (detailed and shaded--Color)

Heart Model Photographs (B & W)

Heart Model Photographs (Color)

Realistic Photographs (B & W)

Realistic Photographs (Color)

Low Efficiency in Facilitating Learning High

Figure 1. Realism Continuum for Still Visuals

Objective

The primary purpose of this study was to measure the effectiveness of eight types of visual illustrations used to complement programed instruction and to evaluate the realism continuum for still visuals as a reliable predictor of visual effectiveness. Each visual sequence existed in two versions (B & W and Colored); consequently an attempt was also made to evaluate the instructional value of the color variable in facilitating student achievement on the five criterion measures used in this study.

Specifically, the purposes of this study were:

(a) to measure the relative effectiveness of eight different types of visual illustrations designed to complement programed instruction;

(b) to evaluate the realism continuum for still visuals as a reliable predictor of visual learning;

(c) to determine whether the amount of time that students study their respective instructional presentation affects their achievement on the criterion measures;

(d) to determine whether color in visual illustrations is an important variable in promoting student achievement of the five educational objectives measured in this study.

Procedure

The experimental population for this study consisted of one hundred seventy-five freshmen students at the Pennsylvania State University. Students were randomly assigned to one of the nine treatment groups. Each of the treatment groups received their instruction via programed booklets consisting of 37 paragraph type frames on $8\frac{1}{2}$" by $5\frac{1}{2}$" sheets; each frame contained a $2\frac{1}{2}$" by $3\frac{1}{4}$" plate designed to complement the verbally programed instruction. The eight treatment groups receiving visual illustrations in their respective programed booklets were considered to be the experimental groups and the programed treatment which contained no visual illustrations of the heart was considered to be the control group. The heart was selected as the subject content for this investigation because it permitted the evaluation of several types of learning objectives as measured by the five criterion tests used in this study.

Treatment Groups

Information transmitted via the verbally programed channel was held constant for each presentation and the amount of realistic detail contained within the visual illustrations was varied. Students in Group I received no visual illustrations but viewed printed word symbols;

Group II viewed abstract line illustrations (B & W); Group III viewed abstract line illustrations (Colored); Group IV viewed detailed, shaded drawings (B & W); Group V viewed detailed, shaded drawings (Colored); Group VI viewed photographs of a heart model (B & W); Group VII viewed photographs of a heart model (Colored); Group VIII viewed realistic heart photographs (B & W), and Group IX viewed realistic heart photographs (Colored). Students were permitted to take as much time as they needed to work through the instructional unit; however, they were asked to indicate on the booklet the amount of time it took them to complete their instruction.

Criterion Measures

Each student in each treatment group received a pretest, participated in his respective instructional presentation and then received four individual criterion tests. Scores received on these tests were combined into a 78-item total criterion test. The objective of each test was as follows: (a) drawing test - to evaluate student learning of specific locations of the various patterns, structures, and positions of the parts of the heart; (b) identification test - to measure student transfer of learning, i.e., the ability to identify numbered parts on a diagram of

the heart from information presented via the instructional presentation; (c) terminology test - to evaluate student knowledge of referents for specific symbols; (d) comprehension test - to measure student understanding of the heart, its parts, its internal operations, and the simultaneous processes which occur during the systolic and diastolic phases, and (e) the total criterion test - to measure the student's total understanding of the concepts presented in the instruction. The Kuder-Richardson formula 21 reliability coefficient for the five criterion measures were: (a) drawing test .67; (b) identification test .80; (c) terminology test .73; (d) comprehension test .72; and (e) total criterion test .91.

Experimental Design

Analysis of variance was computed on the amount of time taken by students in each treatment group to complete their respective instructional units. An analysis of covariance, utilizing scores on the 36-item physiology pretest, was used to determine the significance of differences in achievement for the nine treatment groups on the five criterion measures. If significant differences due to treatment effects were found to exist among the means on the analysis of variance and covariance procedures,

differences between pairs of means were analyzed by Dunn's c-Procedure.

Results

Analysis of the data revealed that significant differences in time ($p < 0.01$) existed among the means of the nine treatment groups receiving the varied instructional treatments (See Table 1).

Table 1. Time Analyses

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A. GROUP MEANS

	GRP I (N=18)	GRP II (N=19)	GRP III (N=18)	GRP IV (N=22)	GRP V (N=20)	GRP VI (N=19)	GRP VII (N=19)	GRP VIII (N=19)	GRP IX (N=21)
MEAN (IN MINUTES)	26.11	33.13	27.00	30.03	26.00	31.00	29.14	29.35	29.11
S.D.	5.77	10.40	4.55	5.75	7.13	5.20	3.75	3.01	4.10

B. ANALYSIS OF VARIANCE ON TIME

VARIATION	df	SUMS OF SQUARES	MEAN SQUARE	F RATIO	SIGNIFICANCE
Among Groups	8	795.16	99.40	2.86	($p < .01$)
Within Groups	166	5780.27	34.82		
Total	174	6575.43			

C. DUNN'S C-PROCEDURE FOR DIFFERENCES

BETWEEN PAIRS OF MEANS

	GRP II	GRP III	GRP IV	GRP V	GRP VI	GRP VII	GRP VIII	GRP IX
GRP I	*3.62	.45	2.10	.06	2.52	1.56	1.67	1.58
GRP II		3.16	1.68	*3.78	1.12	2.09	1.98	2.16
GRP III			1.62	.52	2.06	1.10	1.21	1.11
GRP IV				2.22	.52	.49	.37	.52
GRP V					2.65	1.66	1.77	1.69
GRP VI						.97	.87	1.01
GRP VII							.11	.02
GRP VIII								.13
GRP IX								

*Significant ($p < .05$)

On the total criterion test and on the four individual criterion tests, differences were found to exist among the means of the nine treatment groups. The F ratios for the adjusted analyses of covariance were found to be significant at the 0.01 level for the drawing, terminology, and total criterion tests; differences on the identification test were found to be significant at the 0.05 level. No significant differences were found to exist among the means of the nine treatment groups on the comprehension test. On those criterion measures where the F ratio reached a significant level, Dunn's "c" Procedure was employed to test the difference between pairs of means. Table 2 reports the results of this test.

Table 2. Dunn's c-Procedure Showing Significant Mean Comparisons

Table 2. Dunn's c-Procedure Showing Significant Mean Comparisons

A. Drawing Test

Treatment	Mean Physi-ology Pretest Score	S. D.	Mean	Adj. Mean	Grp II (15. 40)	Grp III (14. 85)	Grp IV (12. 33)	Grp V (15. 20)	Grp VI (11. 33)	Grp VII (15. 43)	Grp VIII (12. 19)	Grp IX (13. 64)
Grp I	23. 33	3. 0	10. 11	10. 08	**5. 47	**5. 08	2. 51	**5. 59	1. 35	**5. 77	2. 28	*3. 93
Grp II (B&W)	21. 79	2. 5	15. 05	15. 40		.59	*3. 48	. 22	**4. 45	. 03	3. 51	1. 97
Grp III (Color)	23. 83	2. 4	15. 00	14. 85			2. 81	. 38	*3. 80	. 63	2. 87	1. 34
Grp IV (B&W)	23. 36	3. 9	12. 36	12. 33				3. 29	1. 13	*3. 51	. 16	1. 52
Grp V (Color)	25. 70	1. 4	15. 80	15. 20					**4. 28	. 25	3. 33	1. 77
Grp VI (B&W)	21. 42	3. 4	10. 90	11. 33						**4. 48	. 94	2. 59
Grp VII (Color)	22. 32	2. 7	15. 21	15. 43							*3. 54	2. 01
Grp VIII (B&W)	21. 37	3. 8	11. 74	12. 19								1. 62
Grp IX (Color)	25. 48	2. 3	14. 19	13. 64								

B. Identification Test

Treatment	S. D.	Mean	Adj. Mean	Grp II (14. 92)	Grp III (15. 48)	Grp IV (13. 19)	Grp V (13. 59)	Grp VI (11. 55)	Grp VII (16. 25)	Grp VIII (13. 95)	Grp IX (13. 38)
Grp I	3. 0	12. 11	12. 05	2. 48	2. 92	1. 01	1. 34	. 44	*3. 63	1. 64	1. 17
Grp II (B&W)	3. 4	14. 11	14. 92		. 49	1. 57	1. 18	2. 96	1. 17	. 85	1. 39
Grp III (Color)	1. 4	15. 83	15. 48			2. 05	1. 66	3. 41	. 67	1. 33	1. 86
Grp IV (B&W)	3. 9	13. 27	13. 19				. 37	1. 49	2. 78	. 69	. 18
Grp V (Color)	3. 9	15. 00	13. 59					1. 81	2. 37	. 32	. 19
Grp VI (B&W)	5. 4	10. 53	11. 55						* 4. 13	2. 11	1. 65
Grp VII (Color)	3. 9	15. 74	16. 25							2. 02	2. 58
Grp VIII (B&W)	4. 6	12. 90	13. 95								. 51
Grp IX (Color)	5. 1	14. 67	13. 38								

C. Terminology Test

Treatment	S. D.	Mean	Adj. Mean	Grp II (14. 72)	Grp III (14. 69)	Grp IV (14. 07)	Grp V (15. 86)	Grp VI (12. 72)	Grp VII (15. 02)	Grp VIII (14. 04)	Grp IX (16. 17)
Grp I	2. 5	12. 67	12. 65	1. 83	1. 78	1. 30	2. 87	. 06	2. 09	1. 23	3. 18
Grp II (B&W)	4. 5	14. 53	14. 72		. 03	. 60	1. 03	1. 79	. 27	. 61	1. 33
Grp III (Color)	2. 2	14. 78	14. 69			. 57	1. 05	1. 74	. 29	. 57	1. 34
Grp IV (B&W)	3. 3	14. 09	14. 07				1. 68	1. 25	. 88	. 03	2. 00
Grp V (Color)	3. 0	16. 20	15. 86					2. 85	. 76	1. 65	. 29
Grp VI (B&W)	5. 5	12. 47	12. 72						2. 06	1. 18	3. 16
Grp VII (Color)	2. 8	14. 90	15. 02							. 88	1. 05
Grp VIII (B&W)	3. 8	13. 79	14. 04								1. 95
Grp IX (Color)	2. 2	16. 48	16. 17								

D. Total Criterion Test

Treatment	S. D.	Mean	Adj. Mean	Grp II (57. 94)	Grp III (58. 18)	Grp IV (50. 45)	Grp V (59. 11)	Grp VI (46. 71)	Grp VII (60. 54)	Grp VIII (52. 88)	Grp IX (55. 90)
Grp I	8. 7	48. 00	47. 86	2. 84	2. 87	. 76	3. 21	. 04	*3. 58	1. 42	2. 32
Grp II (B&W)	12. 2	56. 16	57. 94		. 07	2. 22	. 34	2. 92	. 74	1. 45	. 60
Grp III (Color)	5. 7	58. 94	58. 18			2. 26	. 27	2. 95	. 67	1. 49	. 66
Grp IV (B&W)	12. 2	50. 64	50. 45				2. 60	. 81	2. 99	. 72	1. 66
Grp V (Color)	9. 7	62. 20	59. 11					3. 30	. 41	1. 80	. 95
Grp VI (B&W)	18. 1	44. 47	46. 71						*3. 67	1. 48	2. 40
Grp VII (Color)	10. 5	59. 42	60. 54							2. 19	1. 36
Grp VIII (B&W)	12. 7	50. 58	52. 88								. 88
Grp IX (Color)	10. 2	58. 71	55. 90								

*(p<. 05)
**(p<. 01)

Interpretation

In terms of economy and instructional effectiveness:

(1) The abstract line presentation (B & W) should be used to promote student achievement on the drawing test;

(2) The programed presentation without visuals should be used to promote student achievement of those objectives measured by the terminology and comprehension tests;

(3) The heart model presentation (Color) should be used to promote student achievement of those objectives measured by the identification and total criterion tests.

Summary

The results of this study indicate that students who received the programed instruction complemented by line drawings required significantly more time to complete their instruction than did students who received the programed instruction alone and those who viewed the detailed drawing presentation (Color). In fact, students who viewed the abstract line drawings required more time to complete their instruction than did each of the other treatment groups; however, these differences did not reach the .05 level of significance.

The results also indicated that in terms of economy and instructional effectiveness the abstract line presentation should be used to facilitate student achievement on the drawing test. Thus, it seems that students do not know how to learn from drawings and photographs, their previous exposure to these media being merely to acquaint them with reality. Their success with the line drawings may be attributed to their prior school experience where they have learned to interact effectively with this type of visual.

Another possible explanation may be advanced for the failure of the visually complemented presentations to facilitate student achievement. These visuals contained more realistic detail and it is possible that this detail distracted the students from the relevant learning cues and thereby hindered their acquisition of the intended information. It may also be that student achievement of educational objectives measured by the criterion tests did not require students to effectively utilize the information presented in the more realistic illustrations.

On the terminology and comprehension tests it was found that the programed presentation alone was as effective in facilitating student achievement as were the visually complemented presentations. The effectiveness of the verbal presentation alone may be appreciated more fully

if we recall that a major portion of the information that a student acquires is obtained in this manner. Out of necessity students have developed the ability to select from verbally prepared instructional units that information which is important and essential. It may be that in order to promote student achievement on criterion measures such as the terminology and comprehension tests visuals are not necessary and when used do not measurably improve student achievement.

In terms of instructional effectiveness it was found that the colored version of the heart model presentation was most effective in transmitting that information which was measured by the identification test. Apparently the use of color in facilitating this type of student achievement is an important instructional variable. Although the colored heart model presentation was not the most effective presentation in promoting student achievement on the drawing and total criterion tests, it was found to be significantly more effective than its counterpart, the black and white version, on these two criterion measures.

A number of important generalizations emerge regarding the use of visual illustrations designed to complement programed instruction in the biological sciences. Further research is needed to determine whether the same generalizations are true in different content areas and for students at different grade levels.

1. A realism continuum of visual illustrations extending from a line drawing to the object or situation itself is not the most effective predictor of learning effectiveness for all kinds of educational objectives. It would seem that some visuals are better than others in facilitating student achievement of specific educational objectives.
2. The addition of color in specific types of visual illustrations which are to be presented to college freshmen is an important instructional variable to be used in facilitating student achievement of specific educational objectives.
3. In general, students who receive the programed material complemented by abstract line illustrations required a longer period of time to complete their instructional units.

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